DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 450

[Docket No. FAA–2025–0798]

Agency Advisory Circular: Reduced Reliability Flight Safety System Design, Test, and Documentation

AGENCY: Federal Aviation Administration (FAA), Department of Transportation (DOT).

ACTION: Notification and request for comments.

SUMMARY: FAA invites public comments about our intention to publish an advisory circular. This Advisory Circular (AC) provides guidance to demonstrate compliance with the design, test, and documentation requirements for a Reduced Reliability Flight Safety System (RRFSS) of commercial space launch or reentry vehicles. This AC presents one acceptable means of compliance (MOC), but this is not the only acceptable MOC. Launch and reentry license applicants may use this AC to guide their internal processes, format their license applications, or both.

DATES: Written comments should be submitted by June 13, 2025.

ADDRESSES: Please send written comments:

By Electronic Docket: www.regulations.gov (Enter docket number into search field).

By mail: Charles Huet, 800 Independence Avenue SW, Room 331, Washington, DC 20591.

FOR FURTHER INFORMATION CONTACT: Charles Huet by email at: *Charles.huet@faa.gov;* phone: 202–267–7427.

SUPPLEMENTARY INFORMATION:

I. Authority

The Commercial Space Launch Act of 1984, as amended and codified at 51 U.S.C. 50901 through 50923, authorizes the DOT, and the FAA through delegation, to oversee, license, and regulate commercial launch and reentry activities, and the operation of launch and reentry sites as carried out by U.S. citizens or within the United States. The FAA exercises these responsibilities consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. See 51 U.S.C. 50905.

II. Text of Draft Advisory Circular

1.1 Purpose

1.1.1 This Advisory Circular (AC) provides guidance to demonstrate compliance with the design, environment, test, analyses, and documentation requirements for a Flight Safety System (FSS) under 14 CFR 450.143.

1.1.2 Per § 450.108(b)(2), a vehicle operator using flight abort as a hazard control strategy to meet the safety criteria of § 450.101 must use a FSS that either:

(1) Meets the requirements of § 450.145 if the consequence of any reasonably foreseeable failure mode in any significant period of flight is greater than $1\text{x}10^{-2}$ conditional expected casualties (CEc) in uncontrolled areas; or

(2) Meets the requirements of § 450.143 when the consequence of any reasonably foreseeable failure mode in any significant period of flight is between $1\text{x}10^{-2}$ and $1\text{x}10^{-3}$ CEc for uncontrolled areas.

A FSS that meets the requirements of § 450.145 is known as a Highly Reliable Flight Safety System (HRFSS). A FSS that meets the requirements of § 450.143 is known as a Reduced Reliability Flight Safety System (RRFSS). This AC only provides guidance for an RRFSS.

Compliance with § 450.143 should ensure that no credible fault (§ 450.143(b)) can lead to increased risk to the public beyond nominal safety-critical system operation. The guidance of this AC (see Figure below) should be used to develop a program-specific means of compliance (MOC) document, which must be expanded to include component-specific design and test details, similar to the most updated Range Commanders Council (RCC) 319 and RCC 324 content such as test matrices and definition of performance tests.

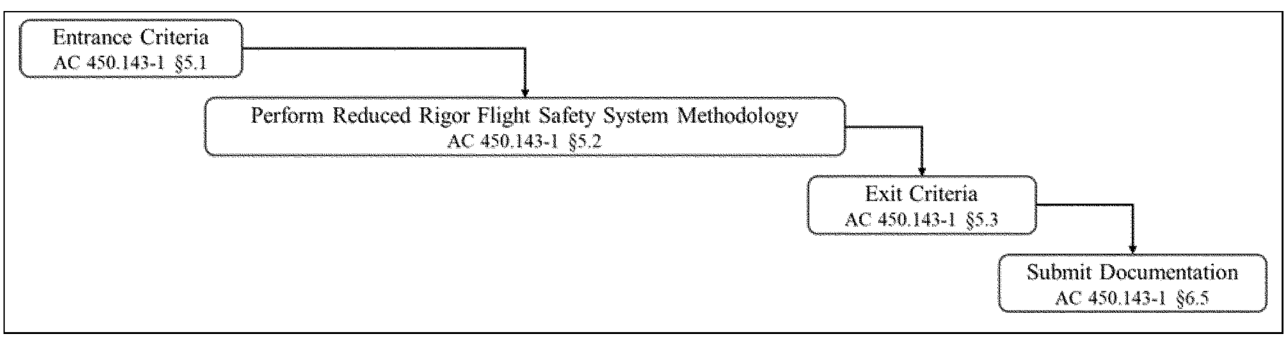

Figure 1: AC 450.143–1 Document Flow

1.1.3 Other approaches that fulfill regulatory objectives may be acceptable to the Federal Aviation Administration (FAA) Office of Commercial Space Transportation (AST). This AC presents one, but not the only, acceptable MOC with the requirements of § 450.143. The FAA should consider other MOC that an applicant may elect to present that also satisfy the entrance and exit criteria defined within this AC.

1.1.4 Applicants are advised to refer to AC 450.108–1, Flight Abort Rule Development, for all un-crewed vehicles whose FSSs used during commercial space launch or reentry operations are required to have flight abort capability and comply with § 450.108(b)(2) and AC 450.107–1, Hazard Control Strategies Determination, to determine which strategies to use.

1.2 Scope

1.2.1 This initial release of AC 450.143–1 is for a single-use FSS only.

1.2.2 A FSS is composed of two major sub-systems: the Flight Termination System (FTS) and the Range Tracking (and Telemetry) System (RTS). This initial release of AC 450.143–1 provides a MOC for the FTS of an RRFSS, but does not address FSS component software, such as that contained on an Automated Flight Termination Unit and typically managed under RCC 319–19 Appendix A for HRFSS, or RTS components for an RRFSS.

1.3 Exception

An applicant should perform design, testing, and documentation in compliance with § 450.143 for FSSs, except for FSSs for which an operator demonstrates through its flight hazard analysis that the likelihood of any hazardous condition specifically associated with the system that may cause death or serious injury to the public is extremely remote, pursuant to § 450.109(b)(3). Thus, this AC does not apply to crewed vehicles that have safety-critical systems for which an operator must demonstrate—using a flight hazard analysis—that the likelihood of any hazardous condition that may cause death or serious injury is extremely remote, pursuant to § 450.109(b)(3).

1.4 Licensing and Regulatory Applicability

1.4.1 This AC presents one, but not the only, acceptable MOC with the associated regulatory requirements. The FAA will consider other MOC that an applicant may elect to present. In addition, an operator may tailor the provisions of this AC to meet its unique needs, provided the changes are accepted as an MOC by the FAA. Throughout this document, the word ''must'' characterizes statements that directly follow from regulatory text and therefore reflect regulatory mandates, or that an applicant must satisfy in order to use this AC as a MOC. The word ''may'' describes variations or alternatives allowed within the accepted MOC set forth in this AC.

1.4.2 The guidance in this AC is for launch and reentry license applicants and operators required to comply with 14 CFR part 450. The guidance in this AC is for those seeking a launch or reentry vehicle operator license, a licensed operator seeking to renew or modify an existing vehicle operator license.

1.4.3 The material in this AC is advisory in nature and does not constitute a regulation. This guidance is not legally binding in its own right and will not be relied upon by the FAA as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with this guidance document (as distinct from existing statutes and regulations) is voluntary only, and nonconformity will not affect rights and obligations under existing statutes and regulations. This AC describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations.

1.4.4 The material in this AC does not change or create any additional regulatory requirements, nor does it authorize changes to, or deviations from, existing regulatory requirements.

2 Applicable Regulations and Related Documents

2.1 Related U.S. Statute

Title 51 U.S.C. subtitle V, chapter 509, Commercial Space Launch Activities.

2.2 Related FAA Commercial Space Transportation Regulations

The following regulations from title 14 of the CFR must be accounted for when showing compliance with § 450.143. The full text of these regulations can be downloaded from the U.S. Government Printing Office e-CFR. A paper copy can be ordered from the Government Printing Office, Superintendent of Documents, Attn: New Orders, PO Box 371954, Pittsburgh, PA 15250–7954.

- Section 401.7, *Definitions.*
- Section 450.101, *Public Safety Criteria.*
- Section 450.107, *Hazard Control Strategies.*
- Section 450.108, *Flight Abort.*
- Section 450.109, *Flight Hazard Analysis.*
- Section 450.115, *Flight Safety Analysis Methods.*
- Section 450.141, *Computing Systems.*
- Section 450.131, *Probability of Failure Analysis.*
- Section 450.143, *Safety-Critical System Design, Test, and Documentation.*
- Section 450.145, *Highly Reliable Flight Safety System.*
- Section 450.161, *Control of Hazard Areas.*
- Section 450.209, *Compliance Monitoring.*

2.3 Related U.S. Statute

These FAA Advisory Circulars are or will be available through the FAA website, *https://www.faa.gov.*

- AC 450.35–1, *Means of Compliance Process,* when published.
- AC 450.101–1, *High Consequence Event Protection,* May 20, 2021.
- AC 450.107–1, *Hazard Control Strategies Determination,* July 27, 2021.
- AC 450.108–1, *Flight Abort Rule Development,* July 27, 2021.
- AC 450.141–1A, *Computing Systems Safety,* August 16, 2021.
- AC 450.143–2, *Systems Safety Critical Components,* when published.

2.4 Related Government Documents

- MIL–STD–461, *Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment,* dated December 11, 2015, or latest revision. *https://quicksearch.dla.mil//qsDocDetails.aspx?ident_number=35789.*
- MIL–STD–810, *Environmental Engineering Considerations and Laboratory Tests,* dated May 18, 2022, or latest revision. *https://quicksearch.dla.mil//qsDocDetails.aspx?ident_number=35978*
- National Aeronautics and Space Administration (NASA) NASA–HDBK–7004, *Force Limited Vibration Testing,* dated May 16, 2000, or latest revision. *http://everyspec.com/NASA/NASA-NASA-HDBK/NASA-HDBK-7004_15229/.*
- NASA–HDBK–7005, *Dynamics Environmental Criteria,* dated March 21, 2017, or latest revision. *https://ntrs.nasa.gov/citations/20190026820.*
- NASA/SP–20230004376, *Methodology for Physics of Failure-Based Reliability Assessments Handbook,* dated June 1, 2024, or latest revision. *https://ntrs.nasa.gov/citations/20230004376.*
- Office of Management and Budget (OMB) Circular A–119, *Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities,* dated February 10, 1998, or latest revision. *https://www.whitehouse.gov/wp-content/uploads/2017/11/Circular-119-1.pdf.*
- Range Commanders Council (RCC), *IRIG Standard 253–93, IRIG Standard Missile Antenna Pattern Coordinate System and Data Formats,* dated August 1993, or latest revision. *https://www.trmc.osd.mil/wiki/display/publicRCC//253+IRIG+Standard+Missile+Antenna+Pattern+Coordinate+System+and+Data+Formats.*
- Range Commanders Council (RCC), *Standard 319–19, Flight Termination Commonality Standard,* dated June 2019, or latest revision. *https://www.trmc.osd.mil/wiki/display/publicRCC/319+Flight+Termination+Commonality+Standard.*
- RCC, *Standard 324–11, Global Positioning and Inertial Measurements Range Safety Tracking Systems Commonality Standard,* dated February 2011, or latest revision. *https://www.trmc.osd.mil/wiki/display/publicRCC//324+Global+Positioning+and+Intertial+Measurements+Range+Safety+Tracking+Systems+Commonality+Standard.*
- Space and Missile Systems Center Standard, *Test Requirements for Launch, Upper-Stage, and Space Vehicles,* SMC–S–016, dated September

5, 2014, or latest revision. *https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/ADA619375.xhtml#*.

- SSCI91–701, *The Space Systems Command Launch and Range Safety Program,* dated December 27, 2022, or latest revision. *https://static.e-publishing.af.mil/production/1/ssc/publication/ssci91-701/ssci91-701.pdf*.

2.5 Related Industry Standards

- American National Standards Institute (ANSI)/American Institute of Aeronautics and Astronautics (AIAA) S–102.2.2–2019, *Performance-Based System Reliability Modeling Requirements,* dated September 24, 2014, or latest revision. *https://arc.aiaa.org/doi/book/10.2514/4.867132*.
- Institute of Electrical and Electronics Engineers (IEEE) 1413, *A Standard for Reliability Predictions,* dated October 21, 2011, or latest revision. *https://ieeexplore.ieee.org/document/6058638*.
- Society of Automotive Engineers (SAE) TAHB0009A, *Reliability Program Handbook,* dated May 3, 2019, or latest revision. *https://www.sae.org/standards/content/tahb0009a/*.

3 Definition of Terms

For this AC, the terms and definitions from § 401.7 and this list apply:

3.1 Acceptance Testing

Testing conducted on the qualification and flight hardware after the completion of the manufacturing process. Generally, acceptance tests are performed on each article of the safety-critical flight hardware to verify that it is free of defects, free of integration and workmanship errors, and ready for operational use. For acceptance testing of components deemed safety-critical, acceptance testing should also demonstrate basic flight survivability, and performance to specification requirements. This practice is analogous to environmental stress screening referenced in industry best practices for reliability. Acceptance testing is performed to enveloping maximum predicted environments or minimum workmanship environments.

3.2 Failure

The inability of a system or system component to perform a required function within specified limits.

3.3 Piece-Part

A single electronic component piece not normally subject to disassembly without destruction or impairment of use, such as resistors, capacitors, transistors, and relays.

3.4 Qualification Testing

Testing of a device or component in flight like or operational configuration, to predicted flight environments plus a prescribed margin, to demonstrate that the design, manufacturing, and assembly processes have resulted in hardware that conforms to specifications and performance requirements when subjected to margined environments. Qualification testing also ensures that acceptance testing and planned operations will not damage the component. Qualification test articles are to be expended and should not be used for flight.

3.5 Reliability

The probability an item will perform its intended function with no failure for a given time interval and under given conditions (*e.g.,* environment and loads).

4 Acronyms

AC Advisory Circular
A-h Amp-Hour
AIAA American Institute of Aeronautics and Astronautics
ADS Automatic Destruct System
ANSI American National Standards Institute
AST FAA Office of Commercial Space Transportation
CE_c Conditional Expected Casualty
CFR Code of Federal Regulations
E_c Expected Casualty
E2E End-to-End Testing
EMI Electromagnetic Interference
EMC Electromagnetic Compatibility
FAA Federal Aviation Administration
FMECA Failure Mode, Effects, and Criticality Analysis
FSS Flight Safety System
FTS Flight Termination System
FTSR Flight Termination System Report
HDBK Handbook
HRFSS Highly Reliable Flight Safety System
IEEE Institute of Electrical and Electronics Engineers
MAS Minimum Acceptable Standard
MIL–STD Military Standard
MOC Means of Compliance
MPE Maximum Predicted Environments
NASA National Aeronautics and Space Administration
OMB Office of Management and Budget
PSD Power Spectral Density
RCC Range Commanders Council
RF Radio Frequency
RRFSS Reduced Reliability Flight Safety System
RTS Range Tracking System
SAE Society of Automotive Engineers
SRM Solid Rocket Motor
SRS Shock Response Spectrum
TM Telemetry
U.S. United States

5 Basis for Design

For an RRFSS MOC, an applicant may use RCC 319 and RCC 324, with reductions in the requirements from a HRFSS, including all design, environments, test and analysis rigor, and margins; or an applicant may follow the MOC methodology within this chapter. The MOC provided in this AC is an acceptable baseline for an RRFSS which has reduced requirements for the applicant. The Flight Safety Risk, defined by the Entrance Criteria and validated/approved by the Exit Criteria, is defined within this AC and deemed an acceptable MOC for a RRFSS. As noted above, this AC presents one, but not the only, acceptable MOC with the requirements of § 450.143.

FSS reliability is the reliability of the FSS to perform a termination when required, and to not perform inadvertent termination or termination of a nominal vehicle.

5.1 Entrance Criteria

An applicant seeking approval of an RRFSS design under this MOC must ensure that the following criteria are met prior to submitting documentation to the FAA for approval.

5.1.1 The applicant must submit a CEc analysis to the FAA demonstrating that the consequence of any reasonably foreseeable failure mode in any significant period of flight is greater than 1x10–3 and less than or equal to 1x10–2 CEc, as per §§ 450.108(b)(2), 450.101(c)(2), and 450.115. While an applicant may choose to include an FSS when the CEc value is less than or equal to 1x10–3, an FSS is not required, per § 450.101(c)(2). On the contrary, a HRFSS is required when the CEc value is more than 1x10–2 CEc, per § 450.108(b)(1).

5.1.2 The applicant must submit a preliminary design reliability analysis showing that the design reliability of the FSS has the potential to be greater than or equal to 0.900 at 95 percent lower confidence bound, such that the risk to all members of the public, excluding persons in aircraft and neighboring operations personnel, is less than or equal to 1x10–4 Ec, with Ec determined per § 450.101(a) and (b).

5.2 RRFSS Methodology

Paragraphs 6.1, 6.2, 6.3, and 6.4 provide requirements for a methodology to design and test an FTS that is compliant with § 450.143. The FAA will consider the reliability requirement of 0.900 at 95 percent lower confidence bound met through compliance with this document, which incorporates the following:

- performance-oriented design requirements for components;
- comprehensive acceptance and qualification testing of components; and
- pre-flight confidence tests of the entire system.

The Minimum Acceptable Standard (MAS) for an FSS design is dependent on the design and fulfilling the requirements of the MOC, with consideration to the interdependencies of the requirements.

5.2.1 An RRFSS under this MOC is defined by reduction in requirements from a HRFSS such that reliability is not maintained to the baseline HRFSS, while still meeting performance specifications as a FSS per satisfying the requirements set defined herein.

5.2.2 Based on the FSS design, some requirements of Chapter 6 may not be applicable.

5.2.3 The design of a RRFSS must be compliant with the minimum set of requirements herein but also needs to satisfy all of the Exit Criteria for a specific design configuration. Not all the requirements may be permitted if they result in not satisfying the Exit Criteria.

5.2.4 The developed MOC must include component-specific design and test details, such as any redundancy, test matrices, and performance functional tests.

5.3 Exit Criteria

To have an FTS qualified under this MOC:

5.3.1 The applicant must submit documentation in accordance with paragraph 6.5 of this MOC;

5.3.2 The FSS System Predicted Design Reliability for the proposed RRFSS design must be greater than or equal to 0.900 at 95 percent lower confidence bound; and

5.3.3 The applicant must comply with all the following part 450 criteria based upon final Mission and FSS Design specifications:

a. Conditional Expected Casualty (CEc) between 1x10–2 and 1x10–3 per § 450.108(b)(2).

b. Risk evaluations completed for both proper functioning of and failure of the RRFSS per § 450.108(d)(5).

c. Collective Risk of Expected Casualty (Ec) ≤ 1x10–4 per §§ 450.101(a) or (b) and 450.108(d)(5).

d. Individual Risk Probability of Casualty (Pc) ≤ 1x10–6 per §§ 450.101(a) or (b) and 450.108(d)(5).

e. Aircraft Risk ≤ 1x10–6 per §§ 450.101(a) or (b) and 450.108(d)(5).

f. Risk to Critical Assets ≤ 1x10–3 per §§ 450.101(a) or (b) and 450.108(d)(5).

g. Risk to Critical Payloads ≤ 1x10–4 per §§ 450.101(a) or (b) and 450.108(d)(5).

h. Acceptable Flight Hazard Areas per §§ 450.133, 450.161, and 450.108(d)(5).

i. Conditional Expected Casualty (CEc) for flight abort ≤ 1x10–2 per §§ 450.108(c)(4) and 450.108(d)(5).

6 Reduced Reliability Flight Safety System Baseline Test and Design Requirements

The RRFSS must be compliant with the requirements of the following categories:

- Design requirements.
- Environmental requirements.
- Test requirements.

One means of documenting the flight safety system (FSS) requirements is to start with RCC 319 and RCC 324, adjusting the verbiage to be consistent with the details of this chapter. Alternately, the applicant may use these requirements to develop their own requirements and methodologies document. Any tailoring of these requirements would need to be resubmitted as a new MOC for review and approval.

The Applicant MOC documents will need to be assessed specifically for the components of the FTS design, where specifics not defined herein may be required to be defined per RCC 319–19.

Note: RTS requirement guidance, as noted earlier, is out of scope from this initial AC release. The RRFSS MOC for RTS developed by an Applicant must have traceability to RCC 324–11.

Note: Some requirements include parent references, (Parent: xxx), which provide traceability to the original (highly reliable) requirements, which have been reduced for this AC to meet a § 450.143 RRFSS.

6.1 Design Requirements

Design requirements for an RRFSS should codify the system functional architecture.

6.1.1 FTS Reliability Analysis

Reliability analyses must be provided for the integrated FTS, including both on-vehicle and off-vehicle subsystems as separate analyses. The reliability analyses must identify all credible failure modes and the probability of failure for the FTS. The reliability calculations must consider both operational and non-operational (transportation, handling, integration, pad operations and recovery operations, if applicable) environments. (Parent: RCC 319–19 section 3.2.2)

6.1.2 FSS Reliability Analysis

The FSS must be designed to meet the reliability that would support compliant Exit Criteria, including ensuring that the system is functional (survives) in the environments with margin. A common design practice to ensure this possibility is to design with redundancy and physical separations to minimize common cause failures or environmental impacts to system functionality. Such practices are referenced in RCC 319–19 section 3.2.

6.1.3 FTS Survivability

Regarding system reliability, the FTS must be designed such that it can survive and function nominally for all nominal and off-nominal environments where it may need to take action to ensure that flight abort limits will be enforced. If the FTS cannot survive these environments, its reliability must be considered zero for flight safety analysis purposes. For example, an analysis may be provided to demonstrate a non-surviving FTS on a liquid vehicle is typically not a concern due to vehicle break-up, whereas FTS on solid rocket motors (SRMs) must be demonstrated as able to survive catastrophic events because SRMs typically do not break-up without FSS. (Parent: RCC 319–19 section 3.2.4)

6.1.4 Fail-Safe Components

The use of fail-safe components and/or subsystems must be such that if a failure occurs, the FSS retains the capability to safely terminate or control the operation. Examples of fail-safe components include normally-closed valves for which failure of electrical or pneumatic controls result in cessation of commodity flow, or power-systems which return relays to a default state that activates the termination end effectors. (Parent: RCC 319–19 section 3.5.2)

6.1.4.1 The use of fail-safe components must require an analysis that characterizes the failure modes and consequences of an inadvertent termination, due to the potential higher likelihood of an on-trajectory system failure.

Note: The use of fail-safe components does not necessarily negate the need for redundancy or for the requirement of testing to some defined and accepted standard/method (*i.e.,* SMC–S–016 or RCC 324 test tables).

6.1.5 FTS Component Independence

Lack of independence (*i.e.,* dependence) of FTS components on other mission hardware must verify there are no common-cause, single, or dual failure modes that result in FTS and mission failing concurrently.

Note: All non-conformances, root cause analyses and mitigations/get-well plans against any shared hardware must be approved by FAA ASA–230. (Parent: RCC 319–19 section 3.2.5)

6.1.6 Component Service Life

Component service life must be defined and justified by the Applicant and approved by the FAA. (Parent: RCC 319–19 section 3.2.10)

6.1.7 Consistency of Components

Consistency of components of flight hardware to qualification test hardware must be maintained, including consistency of parts, materials and processes. Any changes to flight hardware requires the FAA notification and approval. (Parent: RCC 319–19 section 3.2.11)

6.1.8 Electronic Piece-Part Requirements

Piece-parts used in RRFSS must be demonstrated through testing, at unit or part level, to ensure parts are free of workmanship errors. In accordance with consistency requirements, piece-parts must also ensure that the parts, materials, and processes used between the qualification test procedure and acceptance test procedure parts are uniform to ensure the qualification units remain representative samples of the flight units.

For piece parts with little or no historical data or that is operating at conditions outside its known envelope, additional testing must be implemented to develop the information necessary to perform a reliability assessment (*e.g.,* in accordance with Society of Automotive Engineers (SAE) TAHB0009 or ANSI/AIAA S–102.2.2–2019) in a statistically valid manner (*e.g.,* § 450.131). (Parent: RCC 319–19 section 3.2.11 and Appendix B)

6.1.9 Functioning Time

The FTS activation time, from command initiation to airborne termination action, must be specified and repeatable to ensure the FSS activates in sufficient time to terminate a vehicle prior to endangering a protected area. This time, with its uncertainty, is required for flight safety analysis incorporation of the flight abort limits. (Parent: RCC 319–19 section 3.2.12)

6.1.10 Component Specifications

Component specifications must be clearly defined for performance within the mission operating parameters, including non-operational and operational activities from manufacturing, transportation, handling and integration, ground operations, flight operations, and post-flight operations. (Parent: RCC 319–19 section 3.2.6)

6.2 Environmental Requirements

Environmental requirements for a RRFSS should codify the limits of the non-operational and operational environments with margin to which the RRFSS must be able to function.

6.2.1 Maximum Predicted Environments

Maximum predicted environments (MPE) must be consistent with P95/50 statistical methodologies, margined as appropriate per paragraph 6.2.2 to include operational and non-operational (transportation, handling, integration, pad operations and recovery operations, if applicable) environments. (Parent: RCC 319–19 section 3.3.2)

6.2.2 Environmental Uncertainty Margins

Environmental uncertainty margin must be included for new, unproven system designs on top of the MPE test levels, where three complete duration missions are required before such margin may be reduced or eliminated. Specific margins must be applied to temperature extremes, shock test levels, and vibration test levels, as a minimum. (Parent: RCC 319–19 section 3.3.2)

6.2.2.1 Temperature extreme margin should be 8°C beyond hot and cold P95/50 temperatures.

6.2.2.2 Shock test levels margin should be +3 dB above P95/50 Shock Response Spectrum (SRS).

6.2.2.3 Vibration test levels margin should be +3 dB above P95/50 Power Spectral Density (PSD).

Note: Such margin is considered inclusive when referencing ‘‘flight-representative’’ test levels.

Note: The applicant may propose margin levels with technical rationale if reduced from the upper limits noted above, where acceptability of such reductions will be considered based upon the component criticality, FSS design, other modified requirements, and satisfying the exit criteria of this AC.

6.2.3 Acceptance Test Environment Levels

Acceptance test environment levels must be the extreme of MPE and minimum workmanship levels. (Parent: RCC 319–19 sections 3.3.3 and 3.3.7)

Note: Minimum workmanship levels for ordnance/pyrotechnic devices and batteries may be different than the values provided below, to be approved on a case-by-case basis by the FAA.

6.2.3.1 Lower temperature extreme should be −24°C or MPE, whichever is colder.

6.2.3.2 Upper temperature extreme should be +61°C or MPE, whichever is hotter.

6.2.3.3 Vibration test levels should be the greater of RCC 319–19 Table 4–4 or MPE for all frequencies between 20 Hz and 2000 Hz.

6.2.4 Qualification Margins for Operational Environments.

Qualification margin must be included for all operational environments to ensure RRFSS performance during off-nominal and anomalous launch vehicle operations, as well as to provide for confidence that the RRFSS components will perform nominally after being subjected to non-flight operations, such as ground testing and check-outs. (Parent: RCC 319–19 sections 3.3.3 and 3.3.7)

6.2.4.1 Temperature Extremes 10℃ Beyond Hot And Cold Acceptance Test Levels

6.2.4.2 Shock Test Levels

- +3 dB above MPE levels for frequencies of 100 Hz to 2000 Hz.
- +4.5 dB above MPE levels for frequencies of 2000 Hz to 10 kHz.

For multi-stage vehicles and strap-on (booster) SRMs, FTS components must also meet a minimum breakup shock level, in addition to the MPE +4.5 dB level, for which the minimum breakup shock level must be up to RCC 319–19 Table 4–5, where lower levels must require approved justification.

A minimum margin of 1.5 dB between MPE levels and qualification test levels must be maintained for all frequencies.

For liquid propellant vehicles, if FTS Break-Up analysis demonstrates FTS survivability, no minimum break-up level is required.

6.2.4.3 Vibration Test Levels

- +4.5 dB above Acceptance Test levels for frequencies of 20 Hz to 2 kHz.
- A minimum margin of 1.5 dB between acceptance test levels and qualification test levels should be maintained for all frequencies.

6.2.5 Electrical Component Test Sequence

Electrical component test sequence should be such that electrical components (active and passive) should be tested for thermal environments, followed by shock environments, and finally by random vibration environments.

6.2.6 Non-Electrical Component Testing

Non-electrical component test sequence should not be constrained for mechanical, pneumatic, and pyrotechnic components, but the operator should provide a rationale for the sequence performed.

6.2.7 Thermal Requirements

Thermal requirements must ensure that the RRFSS components can perform nominally across the representative thermal extremes, defined by hot and cold temperatures during all activities related to the FTS hardware, as well as, transition rates between those temperature extremes. (Parent: RCC 319–19 sections 3.3.3, 4.12.2, and 4.15.2)

6.2.8 Vibration Requirements

Vibration environments must ensure the RRFSS components can perform nominally when subjected to representative dynamic levels due to sources such as, but not limited to, handling, transportation, aero-acoustics, vehicular modal dynamics, and other vehicle component dynamics. (Parent: RCC 319–19 sections 3.3.5, 3.3.6, 3.3.7, 4.12.4, 4.12.5, 4.12.6, 4.15.8, 4.15.9, and 4.15.10)

6.2.9 Shock Requirements

Shock environments must ensure the RRFSS components can perform nominally when subjected to representative shock levels due to sources such as, but not limited to, transportation, lift-off, engine shutdown, and staging. (Parent: RCC 319–19 sections §§ 3.3.9, 3.3.11, and 4.15.11)

6.2.10 Acceleration Environments

On vehicles with greater than 5 Gs of MPE acceleration, components must be tested to acceleration environments. (Parent: RCC 319–19 section 3.3.4).

6.2.10.1 The acceleration environment should be determined for all components, which could be used to inform design to attenuate strong environments, such as the use of vibration and shock isolators

Note: 5 Gs is based upon 1-sigma 6.1 Grms random vibration minimum workmanship equivalency, with some derating.

6.2.11 Electromagnetic Interference/Electromagnetic Compatibility Requirements

Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC) environments must ensure the RRFSS components under representative levels are not adversely influenced by other vehicle components or external sources, nor adversely influence other vehicle components. (Parent: RCC 319–19 section 3.3.12 and 4.15.12)

6.2.12 Non-Operating Environments

Non-operational environments must be defined and verified as being enveloped by operational environments, addressed by analysis/similarity, or characterized for testing. (Parent: RCC 319–19 section 4.14)

Note: Includes fine sand, fungus resistance, etc.

6.2.13 Environmental Monitoring

Environmental monitoring must be performed for both non-operational and operational environments to validate MPEs. (Parent: RCC 319–19 sections 5.1.7 and 5.6.1)

6.3 Test Requirements

Test requirements for a RRFSS should identify particular methodologies to demonstrate the RRFSS satisfies design and environmental requirements. An operator will meet the intent of the reliability requirements through testing. Below are a set of test requirements adapted from the requirements of RCC 319–19 MOC for a § 450.143 RRFSS. However, more rigorous, or additional testing may be necessary to meet the FSS Exit Criteria of paragraph 5.3 and should be further discussed with the FAA.

Follow best test equipment and instrumentation methodologies per RCC 319–19 section 4.7.

6.3.1 Testability

The design of the FTS, components, ground support, and monitoring equipment must allow for the required tests to all the environments of this document to be performed and verified. (Parent: RCC 319–19 section 3.2.7)

6.3.2 Number of Qualification Units

The number of FTS qualification units must be sufficient to demonstrate that the design meets the reliability goal necessary to comply with the Exit Criteria of this AC.

Typically, one to three qualification units are required, based upon the component criticality, and known commercial off-the-shelf or vendor flight heritage. Life testing methods are one way to characterize the number of units needed for test, and such methods may be found in sources such as MIL–STD–810, IEEE 1413, NASA/SP–20230004376, NASA–HDBK–7004, NASA–HDBK–7005 and a variety of other standards and handbooks across government and industry. The specific method chosen to demonstrate this is dependent on the design and its intended environment—due to this, any proposal will need to be reviewed and approved on a case-by-case basis. (Parent: RCC 319–19 Component Qualification Test Matrices)

Exception is that ordnance/pyrotechnic devices may utilize the lot acceptance testing and qualification statistical based methods, similar to RCC 319–19.

6.3.3 Government Test Oversight

Government test oversight must be similar to compliance monitoring as described in § 450.209, with the addition of all testing activities associated with development of license deliverables.

6.3.4 Thermal Test Requirements

Thermal testing must be such that the RRFSS components are subjected to flight-like thermal cycles between hot and cold extremes derived in the environments document and at applicable thermal transition rates for acceptance testing, and with margin for qualification testing.

6.3.4.1 For acceptance testing, all FTS components must undergo a minimum of 8 thermal cycles at acceptance test environments, whereas components with active electronic components must undergo an additional 10 burn-in thermal cycles at the acceptance test environment levels. (Parent: RCC 319–19 section 4.12.2)

6.3.4.2 For qualification testing, all FSS components must undergo a minimum of 2x acceptance test thermal cycles (16 total) at Qualification Test environments, plus MPE thermal cycles to account for the number of planned ground operations, such as tanking tests, engine tests, and extended pad stays. (Parent: RCC 319–19 section 4.15.2)

6.3.4.3 The transition rate between hot and cold must be at an average rate of no less than 3 °C per minute or the MPE ramp rate, whichever is greater, and must not be slower than 1 °C per minute. (Parent: RCC 319–19 sections 4.12.2 and 4.15.2)

6.3.4.4 Dwell durations at high and low temperature extremes must be such that the component reaches thermal equilibrium plus a margin of 5 minutes, but no less than 15 minutes per dwell or sufficiently long enough to perform required component functional verification tests. (Parent: RCC 319–19 sections 4.12.2 and 4.15.2)

6.3.5 Vibration Test Environments

Vibration testing must be such the RRFSS components are subjected to flight-like dynamic test levels for a minimum test duration for acceptance testing, and with margin for qualification testing.

Note: For narrow band vibration peak clipping methodology, reference RCC 319–19 section 7.10.

6.3.5.1 For acceptance testing, all FTS components must undergo a minimum of 1 minute at acceptance test environments in each of three orthogonal axes, or for the MPE duration to which the components are subjected to the environment, whichever is longer. (Parent: RCC 319–19 sections 4.12.4, 4.12.5, and 4.12.6)

6.3.5.2 For qualification testing, all FSS components must undergo a minimum of 2x the acceptance test duration at qualification test environments, plus MPE level duration to account for planned ground operations, such as transportation/handling and engine tests/static fires. (Parent: RCC 319–19 sections 4.15.8, 4.15.9, and 4.15.10)

6.3.6 Shock Test Environments

Shock testing must be such that the RRFSS components are subjected to flight-like shock test levels for sufficient repetitions to envelope the number of events to be experienced during flight, with a margin for qualification.

6.3.6.1 Shock testing must be performed for a component in each positive and negative direction for each mutually perpendicular axes, for 3 times direction, totaling 18 shocks. (Parent: RCC 319–19 section 4.15.11)

6.3.7 Acceleration Test Environments

Acceleration environments must ensure components on vehicles with greater than 5 Gs of MPE acceleration must be tested. (Parent: RCC 319–19 section 4.15.7)

6.3.7.1 For acceptance test, MPE acceleration levels for a duration of 1 minute or MPE duration, whichever is greater.

6.3.7.2 For qualification test, MPE plus 6 dB levels for a duration of 2x acceptance test duration.

6.3.7.3 For 5 Gs or less acceleration environments and components that have small electronic parts and internal components (low mass) must be shown to survive the Acceleration environment by Analysis or Test.

◦ Analyses may use a 2-sigma value in calculating random/sine vibration to acceleration equivalency.

◦ Vibration testing may be used in lieu of acceleration if utilizing a 1-sigma value.

6.3.7.4 All wet cell batteries must be tested, not accomplished by analysis.

6.3.8 Non-Operational Testing

Non-operational testing must be performed per methodologies within RCC 319 19 unless analysis demonstrates enveloping by flight environments. Such environments include, but are not limited to, transportation, handling, and storage related thermal, shock, vibration, and leakage environments. The use of design solutions, such as conformal coatings, can be used towards acceptance rationale for analysis on a case-by-case basis, which will require approval by the FAA. (Parent: RCC 319–19 section 4.14)

6.3.9 Bench Handling Shock Test Requirements

Bench handling shock must be performed per RCC 319–19 on each face of the component for which it could drop, for all edges of the defined faces, as well as a drop from a handling height onto the defined face. (Parent: RCC 319–19 section 4.15.12)

6.3.10 EMI/EMC Test Requirements

EMI Testing must be completed, modified from MIL–STD–461 (latest revision) to only test operational frequency bands of applicable FSS, flight vehicle and ground systems, as defined by ''in-band'' bandwidths. ''In-band'' is to be defined by the user per an approved method, such as 6 dB down from the operational bandwidth limits similar to MIL–STD–461 section 4.3.10.3.1.

The EMI and EMC tests must demonstrate that a component satisfies all of its performance requirements when subjected to radiated or conducted emissions from all vehicle systems and external ground transmitter sources. In addition, the test must demonstrate that the component does not radiate or conduct EMI that would degrade the performance of any other FTS component. (Parent: RCC 319–19 section 4.15.12)

6.3.11 Performance Verification Test Requirements

Performance Verification Tests applicable to specific components must be accomplished per RCC 319–19.

6.3.12 Prelaunch Test Requirements

Prelaunch testing must include acceptance testing of all FSS components, End-to-End (E2E) testing with the final flight configuration, and range-compatibility testing (as applicable). (Parent: RCC 319–19 section 5.2)

6.3.12.1 Components such as flight termination receivers and ordnance firing units must have a 180-day certification. On-vehicle testing after the initial certification may be performed with pre-approved procedures.

6.3.12.2 Range compatibility testing must be performed to verify all FTS and RTS components satisfy all performance specifications in the flight configuration when subjected to a minimum level of electromagnetic noise from any potential source that can affect the mission flight trajectory.

6.3.12.3 E2E must be performed no earlier than 14 days prior to the initial launch date. However, E2E testing must be repeated if at any time after the test, the integrity of the system is suspect or compromised by a configuration change, mating/demating of any connector or wiring harness, lightning strikes, or other event affecting the integrity of the system.

6.3.13 Component Rework/Repair Test Requirements

Reworked and repaired components must undergo all required tests, as approved by the FAA, to ensure the components satisfies all of its performance requirements. If a test failure occurs, it may be necessary to reperform all previous testing. The major consideration is the cumulative effects from all the previous tests that may have contributed to the failure. (Parent: RCC 319–19 section 4.8)

6.3.14 Test Failure Analyses

In the event of a test failure or anomaly, the test item, procedures, and equipment must undergo a written failure analysis. The failure analysis must identify the root cause and mechanism of the failure, isolate the failure to the smallest replaceable item or items, and ensure that there are no design, workmanship, or process problems with other flight components of similar configuration (*i.e.* common cause failures). Corrective actions must also be identified when appropriate. Closure and approval of failure analysis disposition, root cause and corrective action is required prior to flight. (Parent: RCC 319–19 section 4.5.2, 5.1.4, 7.11, and 8.1.2)

6.3.14.1 Unless emergency action is needed to safe the system to protect personnel, in the event of a test anomaly or failure, the test configuration must be frozen until an FAA representative can be contacted. Invasive troubleshooting or corrective action must not begin without FAA approval.

6.3.14.2 Failure Notification

The failure or anomaly of an FTS test must be reported verbally or electronically to the FAA representative within 1 day. Data must be provided in a timely manner that allows the FAA sufficient time to review documentation that supports program schedule.

6.3.14.3 A failure investigation plan or an interim write-up of the failure analysis must be submitted that describes the detailed approach to resolve the anomaly or failure.

6.3.14.4 Failure Reports

Failure reports must be submitted for review and approval, including a summary of test failures where FSS components do not meet performance requirements in the Flight Termination System Report (FTSR), per paragraph 6.5.7 of this AC. All component test failures must be documented in the applicable test reports. This requirement includes failure of tests conducted at the supplier plant, contractor plant, and at the launch site. A formal report containing a description of the failure, an analysis of the failure, and planned corrective actions must be submitted in a timely manner that allows sufficient time to review documentation that supports program schedule. Failure analyses must be submitted for approval within 30 days of failure, stating a root cause. In the event a failure investigation requires more than 30 days for the contractor to resolve, status reports on the failure investigation must be submitted to the FAA every 30 days until the investigation is completed.

6.3.15 Test Tolerances

Test tolerance levels must be met as defined in the following table. (Parent: RCC 319–19 section 4.6)

TABLE 1—TEST TOLERANCES

Test	Tolerance
Sampling Time Interval	±5%.
Temperature	±3 °C.
Pressure:	
Above 1.3 x 10^2 Pascals (1 Torr)	±10%.
1.3 x 10^{-1} to 1.3 x 10^2 Pascals (0.001 Torr to 1 Torr)	±25%.
Less than 1.3 x 10 − 1 Pascals (0.001 Torr)	±80%.
Relative Humidity	±5%.
Acceleration	±10%.
Vibration Frequency	±2%.
Sinusoidal Vibration Amplitude	±10%.
Random Vibration Power Spectral Density (G^2/Hz):	
20 to 100 Hz (5 Hz or narrower bands)	±1.5 dB.
100 to 500 Hz (25 Hz or narrower bands)	±1.5 dB.
500 to 2000 Hz (50 Hz or narrower bands)	±3.0 dB.
Sound Pressure Level:	
1/3 Octave Band	±3.0 dB.
Overall	±1.5 dB.
Shock Response Spectrum (Q = 10):	
1/6 Octave Band Center Frequency Amplitude	+9 dB/−3 dB.
Sample Rate	≥10x Max SRS Frequency and at least 100,000 samples per second.
Static Load	±5%.

6.4 Analyses

Reference RCC 319–19 section 7 as a starting point. These analyses are required documentation deliverables (paragraph 6.5) and, once approved, are Exit Criteria to an approved § 450.143 RRFSS. The FTSR must include a summary of these analyses with a detailed report submitted separately or within the FTSR, as appropriate.

6.4.1 Component Environments Derivation

An analysis that demonstrates the maximum predicted non-operating and operating environmental levels that an FTS component is exposed to, accounting for uncertainties due to flight-to-flight variability and any analytical uncertainty must be provided. All assumptions, derivation techniques (including modeling details), and supporting data must also be included. (Parent: RCC 319–19 sections 3.3.2 and 7.10)

6.4.2 System Reliability

An analysis of the predicted design reliability of the FTS (hardware and software), including effects of storage, transportation, handling, and maintenance, in addition to rework must be provided. The reliability analysis should capture component specific details from the verification & validation, development process and on-going testing and flight data, in addition to system factors, such as software and human factors.

The reliability analysis must be updated, as appropriate, as flight data and component failure data are gathered. (Parent: RCC 319–19 section 7.2)

6.4.3 FMECA/Fault Tree (or Equivalent)

An analysis to identify potential component and subsystem reliability issues that could result in safety issues, leading to specific design requirements must be provided. The Failure Mode, Effects, and Criticality Analysis (FMECA) must list all possible failure modes, the failures' effects on performance, probability of occurrence, and the consequences of their occurrence. The FMECA also identifies single-point failures and functions that are not or cannot be tested (redundancy). This must follow standard industry methodology. (Parent: RCC 319–19 section 7.2)

6.4.4 Radio Frequency Link Margin (as Applicable)

A link is a complete Radio Frequency (RF) path from a transmitter output to the RF input of the airborne radio device or vice versa. A link analysis, showing margin, must be performed for nominal trajectories using vehicle attitude and antenna patterns and errant flight that uses the 95 percent spherical coverage antenna gain. The analysis of the link accounts for all losses such as attenuations, amplification/gains, and free space loss/attenuation in the entire path and then applies a pre-specified margin that ensures the signal-to-noise-ratio is sufficient to reliably transmit and receive the desired signals. A 9 dB margin over 95 percent of the actual antenna patterns for a nominal trajectory must be met.

A mission specific link margin analysis showing positive margin (greater than zero) for RTS ground telemetry must account for acquisition plans, switching plans, coverage plans and antenna link autotrack assignments. (Parent: RCC 319–19 section 7.6; SSCI 91–701 6.9.6.5.5, 6.10.4.4, 27 Dec 2022)

6.4.5 Antenna Patterns

An antenna pattern is a representation of an antenna's radiation or receiving characteristics in geometric space. Antenna pattern test requirements and formats can be found in RCC 253–93. The antenna pattern must demonstrate that the radiation gain pattern of the entire RF receiving system, including antennas, RF cables, and RF coupler, will satisfy all the system's performance specifications. The test must:

- Determine the radiation gain pattern around the vehicle and demonstrate the system is capable of meeting the required performance specifications;
- Emulate flight conditions, including ground transmitter polarization, using simulated vehicle and a flight-configured RF command destruct system;
- Measure the radiation gain for 360 degrees around the vehicle using angle increments that are small enough to identify any deep pattern null. Each antenna pattern gain measurement angle increment must not exceed 2 degrees; and
- Generate an antenna pattern in a data format that is compatible with the format needed to perform the FTS system RF link analysis.

An abbreviated antenna pattern test must ensure that flight hardware have the same characteristics of the qualification test units and detect any antenna pattern changes that might occur due to damage resulting from exposure to environments. The test must use a standard ground plane and verify that a sampling of antenna gain measurements is repeatable. (Parent: RCC 319–19 sections 4.16.5, 4.16.6; RCC 253–93)

6.4.6 RF Radiation

An RF radiation analysis must demonstrate that the system and components satisfy all the performance requirements when subjected to emitting sources on the vehicle and from surrounding environments. This analysis must be performed by comparing the component level MIL–STD–461 EMI/EMC with the energy delivered by any emitting source to ensure that components were tested to correct levels. This analysis is where the in-band frequencies are defined. (Parent: RCC 319–19 section 7.14)

- Emitting sources must include radiation emissions from FTS and other vehicle components.

6.4.7 Battery Capacity

An analysis must be performed to demonstrate that the FTS battery has a manufacturer-specified capacity that is no less than the required operational capacity plus a margin. The operational capacity must be based upon the maximum power required for all components connected to the battery. An example method for calculating battery capacity can be found in RCC 319–19 section§ 3.16.2. (Parent: RCC 319–19 sections 3.9, 3.16, and 7.12)

Operational capacity must be calculated using the following elements:

6.4.7.1 The specified capacity must include a margin of at least 0.5 A-h over the required capacity.

6.4.7.2 Batteries must have a lifetime of at least 150 percent of the required mission time from transfer to internal power to FTS safing (*i.e.,* a 50 percent margin on lifetime).

6.4.7.3 Charge capacity must be based on the voltage level at the knee in the discharge curve or above the minimum FTS component voltage requirement, whichever is higher.

6.4.7.4 Secondary batteries and cells must have repeatable performance.

6.4.8 FTS Breakup Analysis

A breakup analysis must be performed to determine the design and location of the FTS components and subsystems to ensure that the FTS functions reliably during a vehicle failure. The breakup analysis must account for:

- aerodynamic loading effects at high-angle-of-attack trajectories during early stages of flight;
- a hard-over engine nozzle-induced tumble during various phases of flight for each stage;
- out-of-sequence timing of vehicle staging and other events that could damage FTS hardware or inhibit the functionality of FTS components or subsystems; and
- breakup due to aerodynamic loading effects at high-angle-of-attack trajectories during early stages of flight must be analyzed at time steps no more than five seconds apart.

Note: The purpose of the breakup analysis is to determine where and when a vehicle is most likely to break up under the credible failure scenarios. This data is used to ensure FTS components and separation detection systems are properly designed and located to maximize FTS survivability in the analyzed failure scenarios. (Parent: RCC 319–19 section 7.15)

6.4.9 Qualification-by-Similarity

A qualification-by-similarity analysis must be submitted for review and approval, including technical justification, and detailing any changes between parts. A summary of all qualification-by-similarity analyses must be included in the FTSR with all details captured in individual component test reports. (Parent: RCC 319–19 section 7.12)

6.4.10 Sneak Circuit

With all components functioning nominally, the analysis must demonstrate that there are no latent paths that could cause an undesired event or prohibit function. (Parent: RCC 319–19 section 7.7)

6.4.11 Bent Pin

Each FTS component must undergo an analysis that demonstrates that any single short circuit occurring as a result of a bent electrical connection pin does not result in inadvertent system activation or inhibiting the proper operation of the system. This analysis must include pin-to-pin and pin-to-case. (Parent: RCC 319–19 section 7.5)

6.4.12 Fratricide

An FTS must undergo an analysis that demonstrates that the flight termination of any stage at any time during flight does not sever interconnecting FTS circuitry or ordnance to other stages until flight termination on all the other stages has been initiated. (Parent: RCC 319–19 section 7.4)

6.4.13 Automatic Destruct System Timing Analysis

The Automatic Destruct System (ADS) timing analysis must be provided, calculating the worst-case time between ADS triggering and final destruct action. The analysis must demonstrate that the FTS will function prior to becoming disabled by vehicle breakup. (Parent: RCC 319–19 section 7.17)

6.4.14 Ordnance Initiator Simulator Analysis

The analysis must be provided, demonstrating that the simulator input current, impedance, voltage, optical power, or energy simulates the flight ordnance characteristics. (Parent: RCC 319–19 section 7.18)

6.4.15 In-Flight FTS Analysis

A post-flight analysis must be provided within 60 days from end-of-mission or prior to next flight, demonstrating that the FTS met all applicable performance requirements during flight. Prior flights analysis must be approved before subsequent flights. An analysis must be provided for review and approval for any in-flight anomaly or when termination action is taken. The FAA representatives must participate in the investigation and be given sufficient notice to support all activities. (Parent: RCC 319–19 section 7.19)

6.5 Documentation

This paragraph lists the documents that must be provided to the FAA to comply with this MOC. Submission of these documents satisfies the application requirements at § 450.143(f) for the FTS component of an RRFSS. The applicant will still have to submit documentation for the RTS, as applicable. All documentation must be approved by the FAA, and only then will this chapter meet the Exit Criteria of paragraph 5.3 of this AC.

6.5.1 Means of Compliance Documents

The applicant must provide a document containing the applicable requirements of paragraphs 6.1 through 6.5, which will be the program-specific MOC document for the FTS of the RRFSS. The applicant must provide appropriate documentation for the RTS and FSS Software MOCs that will support being able to demonstrate compliance with § 450.143.

6.5.2 Environmental Derivation

The FTS and each of its components must satisfy all of their performance requirements when subjected to an environment that envelopes their respective MPEs and applicable workmanship levels plus a margin. An applicant must determine the non-operating and operating environmental levels, rates of change, durations, etc., that a component of an FTS will experience. The assumptions, derivation technique, supporting data, and final environments that the FTS components would be exposed to must be included in this document. All FTS component-mounting hardware, cables, and wires must be considered FTS components for the purposes of this document. The derivation may include analysis, modeling, testing and/or monitoring.

Non-operating and operating environments include temperature (including number of thermal cycles and thermal ramp rates), random and/or sinusoidal vibration, shock, acceleration, acoustic vibration, humidity, salt fog, dust, fungus, explosive atmosphere, or electromagnetic energy that apply to a specific vehicle and launch/flight site(s).

All FTS components must be designed to satisfy all performance requirements when subjected to any predicted combined environments (*e.g.,* thermal/acceleration, thermal/vibration, thermal/shock) to which the component may be exposed.

Modifications made to the vehicle that result in a harsher environment than the FTS was qualified for or that modify or interfere with FTS performance will require evaluation and possible re-qualification of the FTS. (Parent: RCC 319–19 sections 3.3.1 and 3.3.2)

6.5.3 Test Plans

Test plan documents identify the high-level test requirements, including the component-specific test levels, test sequence, functional tests, tolerances, and instrumentation requirements. (Parent: RCC 319–19 sections 4.3 and 8.5.4)

6.5.4 Test Procedures

Test procedure documents explain how the test conductor is to perform the testing, in a step-by-step manner including accepted test tolerances and pass/fail criteria. (Parent: RCC 319–19 sections 4.3 and 8.5.4)

6.5.5 Test Reports

Test report documents demonstrate the compliance to all component performance and environmental requirements, including any test discrepancies and failures that were experienced. (Parent: RCC 319–19 sections 8.5.4 and 8.7)

6.5.6 Test Deviations/Non-Conformances

A test deviation or non-conformance report is for failure of tests conducted at the supplier plant, contractor plant or at the launch site/range. This is a formal report containing a description of the failure, an analysis of the failure, and planned corrective actions submitted and approved by the FAA. The report must be submitted to the FAA in a timely manner that allows sufficient time to review documentation that supports the program schedule. The failure analysis must be submitted to the FAA for approval within 30 days of the failure.

A failure of a test unit is defined as a test discrepancy that is due to a design, workmanship, process, or any quality deficiency in the item being tested. Any test discrepancy is considered a failure of the test item unless it can be indisputably determined to have been due to an unrelated cause. A test deviation is any step taken outside of the approved test plan/procedure and must be approved by the FAA.

One method to facilitate management of test deviations and non-conformances is to implement a Failure Reporting and Corrective Action System, which is a closed loop control process that accounts for failures occurring during all phases of testing and operations, including data from incoming inspection, development testing, equipment integration testing and reliability and maintainability testing while emphasizing corrective action. (Parent: RCC 319–19 section§ 4.5.2; SMC–S–016 sections 3.58 and 3.59; Rome Laboratory Reliability Engineer's Toolkit, April 1993)

6.5.7 Flight Termination System Report (FTSR)

The FTSR is a document developed by the applicant and submitted for FAA review and approval. It is a medium through which the FTS approval is obtained, containing a detailed description of the FTS, tailoring summary system analysis results, design data, reliability data, component design data, group support systems data, test data and FTS Telemetry (TM) data. (Parent: RCC 319–19 section 8)

The following must be included in the FTSR document:

• Detailed FTS drawings, schematics, and wiring diagrams. These must also include all plug and jack designations, all pin assignments, and all FTS-to-TM or other vehicle component interfaces. Additionally, all components must be identified by component number and value such that a circuit analysis can be performed.

• Table of contents and glossary.

• Introduction, addressing the scope and purpose of the FTSR.

• FTS General System Description. The general system description section must present a brief description of the vehicle and the FTS. The following items must be included in this section:

1. *Vehicle Description*—brief and general description of the vehicle.

2. *FTS Description*—brief and general description of the FTS, including a block diagram showing the location of all FTS components of the vehicle and the interfaces with other systems.

3. *FTS Cable Diagram*—a cable diagram of the FTS from the antennas to the termination device.

4. *Overall FSS Schematic*—a complete line schematic of the entire FSS from antenna to the termination device,

including TM pick-of points and ground (umbilical) interfaces.

6.5.7.1 FTS Detailed Component and System Description

The detailed system description section includes a complete and detailed narrative description of all the major components of the FTS. The narrative description must include the following items:

1. A complete and detailed description of the FTS operation, including all possible scenarios and a discussion of how the FTS components function at the system and piece-part level.
2. A complete and detailed description of each FTS component and how it functions, including specifications and schematics, mechanical and piece-part specifications, and operating parameters.
3. Detailed schematics and drawings to include the following: the complete FTS, showing component values such as resistance, capacitance, and wattage; tolerance, shields, grounds, connectors, and pin numbers; and TM pick-off points; all vehicle components and elements that interface with or share common cause use with the FTS; and an accounting of all pin assignments.
4. Drawings showing the location of all FTS system and subsystem components on the vehicle that include the following descriptions: component locations, mounting (attach points), orientation, and cable routing; electrical connectors, connections, and the electrical isolation of the FTS; and an illustrated parts breakdown of all mechanically operated FTS components.

6.5.7.2 FTS Analysis Results

A summary of the applicable results of the analyses required in paragraph 6.4 must be included, with detailed analyses submitted separately.

6.5.7.3 FTS Ordnance Classification

The classifications for each ordnance device must be in accordance with the Department of Transportation, Department of Defense, or United Nations regulations. Supporting documentation must be included in this section.

6.5.7.4 FTS Development, Qualification, Acceptance, and Age Surveillance Test Plans, Procedures, and Reports

• A list of test plans, procedures, and reports by title, number, and revision date.

• The maximum predicted flight loads for all anticipated environmental forces such as shock, vibration, and thermal for each FTS component, subsystem, and system.

• A matrix of the actual qualification and acceptance test levels used for each component, subsystem, and system in each test versus the predicted flight levels for each environment. The test tolerance allowed for each operational qualification test must be included.

• A clear identification of those components qualified by similarity analysis or a combination of analysis and test.

• A summary of each applicable test report. The actual test report must be submitted as a stand-alone document.

6.5.7.5 Software and Firmware Independent Verification and Validations

A summary of software and firmware independent verification and validations must be included.

6.5.7.6 FTS Modifications

All modifications to an approved FTS, its associated equipment, component identification, test procedures, or any changes affecting the configuration and integrity of the FTS must be included.

6.5.7.7 FTS Ground Support and Monitoring Equipment

The ground support and monitoring equipment section must include a complete description of the ground test equipment used to check out the FTS, including contractor-peculiar tests. This section must also include specifications, system schematics, and component schematics for program-unique test equipment for the following:

• ordnance initiator simulator;
• the RF ground support system;
• the RF repeater system;
• safety console layout, display arrangement, and function of each monitor;
• safety console terminations including the following:

a. schematics of all FTS monitor circuits from the FTS component pick-off points to the console termination;
b. calibration data for all monitor circuit terminations provided to the console.

• any other ground support and monitoring equipment as required by the FAA.

6.5.7.8 FTS Installation and Checkout

○ The installation and checkout section must include the following information:

○ a list of procedures for checkout, calibration, and installation of all components, systems, and subsystems of the FTS and its associated ground checkout equipment, including launch-day countdown; and

a summary of each task, objective, test configuration, test equipment, and a time sequence flow chart.

6.5.7.9 Exception to Requirements

The section of the FTSR must include all waivers and conditionally compliant requirements.

6.5.7.10 Changes to the FTSR

An initial and draft FTSRs must be submitted for expedited review, as the design progresses, with each updated FTSR containing the latest information on the FTS. The final FTSR must be submitted with sufficient time for final review and approval.

Any changes to the FTS design must result in an immediate update to the FTSR for review and approval by the FAA on a case-by-case basis. Any unauthorized changes to the FTS design will result in automatic revocation of the FTS and as such, the applicant's launch license.

6.5.7.11 Telemetry Measurement

This section provides a list of all FTS TM measurements. This section includes the following minimum information for each measurement:

• description of each parameter;
• TM measurement identifier;
• sample rate;
• minimum and full-scale level;
• resolution;
• engineering units and scaling factors;
• analog or digital.

6.5.7.12 FTSR Appendices

All FTS development, qualification, and age surveillance test reports must be included as stand-alone appendices.

6.5.8 Operational System Reliability Validation Plan

Post-flight verification of the FSS predicted design reliability must be performed, for which the evaluation plan must be approved by the FAA. Deltas between the as-qualified environments and those experienced in flight will need to be reconciled.

Issued in Washington, DC.

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